The monetary policy transmission mechanism under financial dollarisation: the case of Peru 1996–2006

Renzo Rossini and Marco Vega[1]

1. Introduction

This paper surveys the monetary policy transmission mechanism in Peru. The survey covers the most recent empirical papers dealing with the measurement of monetary policy. From the onset we stress that the last ten years have witnessed important changes in monetary policy procedures that led to the adoption of the inflation targeting (IT) framework in 2002.

From the policy perspective, it is important to know the empirics of the monetary policy transmission mechanism, yet the nature of this mechanism is complex. And it is more so in a financially dollarised economy. The degree of financial dollarisation in Peru is still high (around 65 per cent of private credit is denominated in dollars). The high degree of financial dollarisation is key to understanding the transmission mechanism. One important element of the mechanism is the non-linear nature of the balance-sheet effect coming from currency-induced credit risk in the financial system.

The measurement and identification of the deep mechanisms at work in the transmission channel is difficult because monetary policy, as well as the environment surrounding it, has been evolving rapidly. So, uncertainty about the dynamics of the transmission mechanism is an important element the Central Bank of Peru has to deal with. Accordingly, this paper also performs exercises aiming to show the likely effects of central bank policy actions on the nature of the transmission and the way financial dollarisation reduces the monetary policy power to affect inflation. To the practice of monetary policy in a partially dollarised economy, the exercises imply that central bank actions have to be even more pre-emptive with regard to future inflation pressures and more watchful of potential balance-sheet vulnerabilities.

2. Monetary policy evolution in recent years

During the disinflation period (1991–2001), monetary policy in Peru followed a monetary targeting scheme without any commitment to an exchange rate or interest rate level. As mentioned in Rossini (2001), the sizeable degree of asset dollarisation and the high frequency nature of external shocks[2] were key reasons for adopting a managed floating exchange rate regime, whereas the existing high rates of inflation motivated the monetary targeting framework.

The process of disinflation turned out to be gradual (Table 1) not only because central bank credibility recovered slowly but also because of the initial high degree of relative price distortions. Nonetheless, gradualism allowed the real costs associated with the process to be minimised, and by 1997 inflation reached single-digit levels.

---

[1] Central Bank of Peru. The opinions herein belong to the authors and do not necessarily reflect those of the Central Bank of Peru.

[2] Namely terms of trade and supply shocks.

Table 1

Annual rates of inflation

In percentage points

Year	End-of-period
1990	7649.7
1991	139.2
1992	56.7
1993	39.5
1994	15.4
1995	10.2
1996	11.8
1997	6.5
1998	6.0
1999	3.7
2000	3.7
2001	–0.1
2002	1.5
2003	2.5
2004	3.5
2005	1.5
2006	1.1

During the disinflation period, the Central Bank of Peru made several changes in its monetary policy design and instruments, creating the conditions for moving to a fully-fledged inflation targeting regime in 2002.

For instance, when inflation rates reached levels lower than 20 per cent, real demand for domestic currency started growing fast, and for the first time, communication problems about money base targeting arose. In that context, beginning in 1994 monetary policy management improved through announcements of end-of-year inflation targets.

Regarding monetary instruments, at the beginning of the nineties there was a lack of both public and private liquid assets in domestic currency, and therefore forex intervention was the main way to control base money growth. To foster an effective interbank market and the needed monetary regulation in domestic currency, the first step was the removal of high reserve requirements on domestic currency deposits (1991–1993) from an average rate of 40 to 9 per cent. This was followed by the issuance of Certificates of Deposit[3] to allow for contractionary monetary operations (1994) and finally repo operations with the banking system to provide temporary liquidity (1997).[4]

Once inflation narrowed to international levels and monetary base growth became more difficult to predict as well as less correlated with inflation, the monetary targeting scheme proved to be no longer satisfactory. Moreover, a new policy challenge appeared in 2001 in the form of deflationary pressures, which had not been recorded in Peru during the last 70 years and posed a serious threat to the Bank's recently gained credibility.

[3] These are instruments issued by the Central Bank of Peru itself.

[4] When the Government started a programme to develop the domestic public debt market in domestic currency (2001), these securities also became available for repo operations.

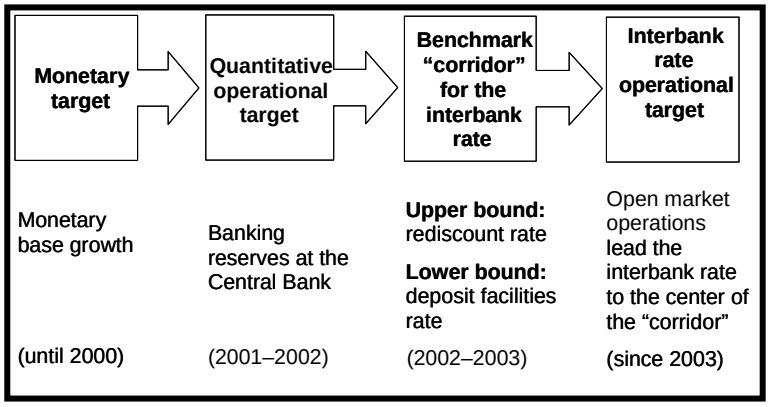
At first, the central bank dealt with such new conditions with a change in the operational target. In 2000, monetary base growth was replaced by a quantitative target: the banking reserves at the central bank. In essence, however, the use of this instrument still relied on the short-run relationship between monetary aggregates and inflation, which explains its abandonment two years later.

In this context, the problem of how to run an expansionary monetary policy without losing credibility in a financially dollarised framework was finally tackled by the central bank with the adoption of inflation targeting in 2002. As described in Armas and Grippa (2006), the characteristics of Peruvian IT are largely similar to those in other countries that have managed to reach and preserve a low inflation rate, consistent with their long-run inflation target level.[5]

With the IT regime, the short-term (interbank) interest rate was introduced as the operational target instead of the monetary aggregate. Figure 1 summarises the evolution of the operational target in recent years.

Figure 1

Evolution of the operational target



The advantages of the current operational target are detailed in Armas and Grippa (2006). These are summarised in four ideas: first, the interbank rate communicates the monetary policy stance clearly; second, this rate is a benchmark for other interest rates denominated in domestic currency;[6] third, the volatility of the interbank interest rate has decreased and the interest rate pass-through has strengthened (Lahura, 2005); and finally, it is flexible enough to allow quick and large increases in the interbank interest rate during extreme situations, to limit currency depreciation and prevent balance-sheet effects from undermining economic activity and the solvency of the financial system.

[5] Inflation targeting in Peru hinges on the central bank commitment to keep inflation on target. From 2002 to 2006, the target was 2.5 per cent with a tolerance margin of +/– 1 per cent. From 2007 onwards, the target is 2.0 per cent with a tolerance margin of +/– 1 percent.

[6] The Peruvian currency is the new sol.

3. The existing empirical evidence

A decade ago, De la Rocha (1998) presented a first general overview about the transmission mechanism of monetary policy in Peru. That view relied on three channels: money, credit and the exchange rate. In those years, the influence that the central bank exerted over monetary aggregates was regarded as the most important channel. This was the primary reason for using the monetary base growth as intermediate target even until 2000 (see Figure 1).

De la Rocha (1998) suggests the existence of uncertainty surrounding credit channel effectiveness after the structural changes faced by the Peruvian economy during the nineties. He contrasts factors reducing the effectiveness against others improving it.[7] On the other hand, it seems that the main concern about the exchange rate channel was the balance-sheet effect rather than the direct pass-through to prices. In that context, the role for central bank intervention as a means for taming exchange rate volatility was highlighted.

Empirical research assessing the transmission mechanism of monetary policy in Peru came to light in the second half of the nineties. Early papers highlighted the use of monetary aggregates as the instrument of monetary policy. More recent research, reflecting the change in operating procedures at the central bank, started focusing on the interest rate as the preferred instrument variable.

We divide the current discussion on the transmission mechanisms, studying the interest rate and exchange rate channels, the expectations channel, the credit channel and, given the existing financial dollarisation, we also look into vulnerability issues constraining monetary policy.

3.1 Interest rates and exchange rate channels

Recent VAR evidence on the transmission mechanism is provided in Winkelried (2004), Grippa (2004), Bigio and Salas (2006) and Leiderman (2005). Winkelried (2004) finds rather short and simultaneous responses of both GDP and inflation to an interest rate shock (less than a year). In contrast, Grippa (2004), following a structural identification approach, finds longer monetary policy lags (the peak response of output was in about 18 months after the shock while prices achieve the larger change only three years after).

From the policy perspective, the above two results regarding the transmission lag prove its uncertain nature. In fact, the evolving feature of monetary policy operating procedures over the sample period[8] hampers empirical estimations. The functioning of the transmission mechanism has surely also been changing as the direct influence of the continuous improvement of the monetary policy design, its transparency and communication, not to mention the increasing sophistication of financial markets and financial globalisation. Therefore, VAR models that try to extrapolate past behaviour onto an ever-changing environment have only limited scope. Yet, there are no other sensible alternatives available.

One of the elements of the complexity of the transmission mechanism is the non-linear feature of the transmission. Non-linearities are documented in Bigio and Salas (2006), who find that contractionary monetary policy shocks have a stronger effect on output during recessions than

[7] Higher capital mobility and the development of the domestic capital market are considered as factors reducing the credit channel effectiveness, whereas restoration of confidence in the banking system and higher bank intermediation tend to increase the effectiveness of this channel.

[8] Due to the short sub-sample periods, in-depth empirical analysis cannot be performed.

during booms, suggesting the existence of a convex supply curve. In the exercises they perform, monetary policy affects output in about a year and prices in about 16 months.

All in all, as the monetary policy design evolved to suit the developments in the economy, the supporting empirical literature shifted in the same fashion. In the process, the literature finds some evidence that the interest rate channel has become stronger. This is probably the result of the increasing importance of the interest rate as a monetary policy signal and the expanding capital markets within the longer-term maturity spectrum.[9] Moreover, as is typical in small open economies, when the interest rate channel becomes relatively more relevant than the pass-through channel, then the transmission lags turn out to be longer.

However, the above development in the interest rate channel can be potentially dampened by financial dollarisation. As we consider in Section 4, financial dollarisation implies that exchange rate depreciations are contractionary. In this case, the monetary policy power to affect prices via the standard domestic demand channel weakens.[10]

The pass-through from exchange rates to inflation

We now turn our attention to the pass-through from exchange rates to inflation. Many authors suggest the exchange rate pass-through ought to be larger in a dollarised economy than in non-dollarised countries. Importantly, if the pass-through were indeed large, this would heighten the power of monetary policy to affect inflation through the exchange rate channel. However, we shall bear in mind two developments regarding the pass-through in Peru and elsewhere:

(i) There is now a body of research that supports a declining pass-through in developed as well as developing economies.[11]

(ii) The pass-through of exchange rates to domestic prices depends on invoicing practices. Incomplete pass-through characterises developing economies because invoicing of imported goods is made in domestic currency (pricing to market). In Peru, high inflation in the past probably favoured heavy invoicing dollarisation even at the retail level; so when inflation faded, the pass-through also fell. Furthermore, the central bank fostered the introduction of legal measures geared to induce invoicing in domestic currency at the retailer level.[12] As a result, invoicing dollarisation has decreased substantially.

Therefore it is no surprise that empirical papers dealing with estimating exchange rate pass-through to prices have found low pass-through levels. For example, Quispe (2001) finds that a 1 per cent depreciation of the exchange rate produces 0.12 per cent of extra inflation.

More recent empirical explorations by Miller (2004) and Winkelried (2004) come up with similar results: a 1 per cent shock on the exchange rate has an effect on CPI inflation in the

---

[9] See Armas and Grippa (2006) for a detailed account of the development of the local government bond market in domestic currency. See also Lahura (2005) for estimations of the pass-through of short-term to longer-term interest rates.

[10] Another factor that might explain the general weakening of the domestic demand channel in the world is trade globalisation. This is, for example, the idea put forward in Vega and Winkelried (2005) and Borio and Filardo (2006).

[11] In particular, Edwards (2006) finds that those countries that adopted the IT regime had a stronger reduction in their pass-through coefficients. On the other hand, Frankel et al (2005) find that pass-through reduction in developed countries was even faster than observed in developing countries.

[12] In 2004 a law was enacted to induce price advertising in domestic currency. So, even though dollar advertising was not forbidden, price tagging in soles must also be included.

range of 0.1 to 0.2 per cent within a year.[13] These estimations were recently updated and compared to those of Deutsche Bank (2006), which used a similar method for a group of Latin American countries. The updated pass-through was even lower than 0.1, below the mean pass-through for Latin America but higher than those for Colombia and Chile.

This last result is also compatible with the estimations in Leiderman et al (2006), who perform empirical research using VARS. The paper finds the pass-through in Peru was reduced along with the implementation of the IT framework.

Table 2

Empirical evidence

Direct channels

Papers	Method-ology	Sample	Main results
Bringas and Tuesta (1997)	VAR	1991:4–1995:5	– Excess reserves are good indicators of monetary policy. Credit channel is weak.
León (1999)	VAR	1991:6–1998:6	– An innovation to currency in circulation has effects on inflation within 4 to 14 months after the innovation. – No money aggregate is identified with significant effects on output.
Quispe (2000)	VAR	1991:1–1998:6	– Liability dollarisation does not affect the power of monetary policy. – A shock in base money has significant effects on inflation within 8 and 16 months after the shock.
Winkelried (2004)	VECM	1993:1–2003:4	– Results support the existence of interest rate channel as a possible mechanism of action for monetary policy.
Grippa (2004)	VAR	1994:2–2004:2	– The interbank interest rate appears as a reasonable estimation for the appropriate indicator of policy stance.
Bigio and Salas (2006)	Non-linear VAR	1994:1–2004:7	– Interest rate shocks have asymmetric effects: during boom periods, interest rate increases have more effects than interest rate decreases.
Leiderman (2006)	VAR	1993:1–2005:7	– Higher pass-through in Peru than in Chile.

3.2 The expectations channel

There has not been empirical research measuring the expectations channel so far. This has been due to the lack of long-term inflation expectations data. The longest extant sample relies on mean private forecast surveys produced by Consensus Economics, which delivers

[13] Winkelried (2003) finds a non-linear effect whereby the same shock to the exchange rate during a boom period will hit inflation in about 30 per cent.

monthly average responses about the year-on-year inflation expected for current and next calendar years. Using these data and tracking the realised inflation within a year, a time series of one-year-ahead inflation expectations can be calculated. In this subsection, this document presents some preliminary estimation that supports how the expectations channel might have become stronger.

Figure 2

One-year-ahead inflation expectations and inflation targets

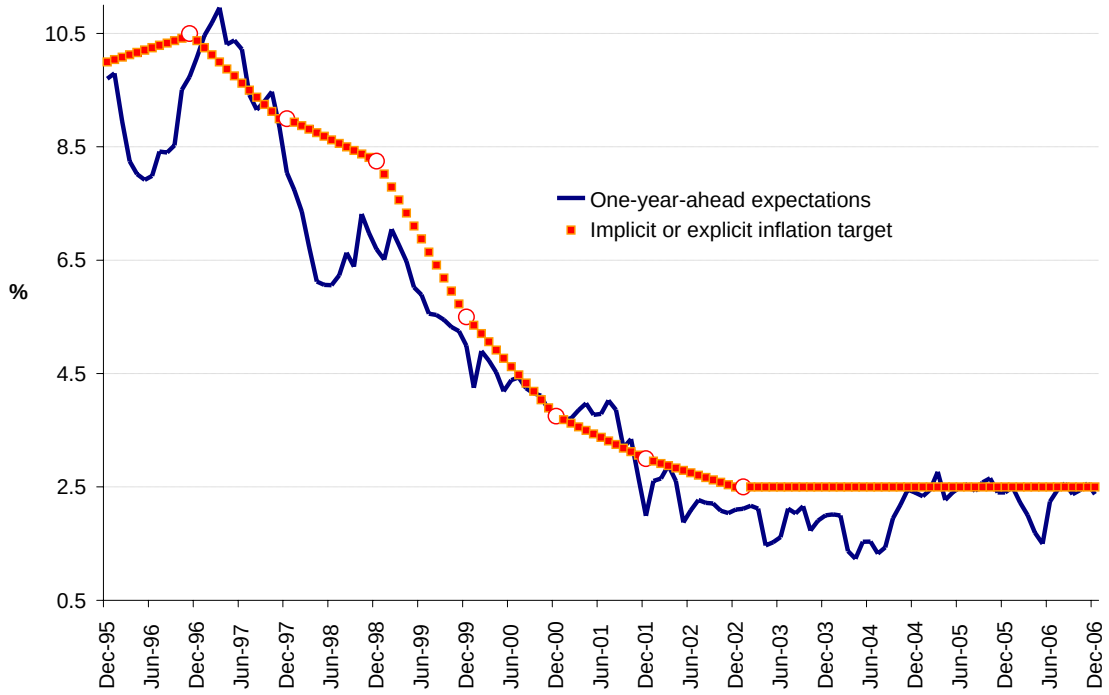


Figure 2 depicts the inflation expectations series. These inflationary expectations can be compared with the inflation target to see how close or far apart they are from each other. It is important to note that until 2001 and since 1994, the central bank announced a desired inflation range for each year.[14] The circles in every December denote the middle values of those ranges. The values for the other months are obtained by simple interpolation, as seen in Figure 2. The target of 2.5 per cent is considered from December 2002 onwards.

From expectation models, it is plausible to consider that the expectation series above vary in time due to changing information and to how private forecasters process information. Forecasters tend to use the announced target as information to form longer-term expectations while they tend to use current information (eg the recently observed inflation evolution) to form shorter-term expectations.

One simple test for improved inflation expectations anchoring is to run a regression of the form

$$\pi^{e}_{t,t+12} = \alpha_t \pi^{target}_{t+12} + (1-\alpha_t)\, \pi_{t-1} \qquad (1)$$

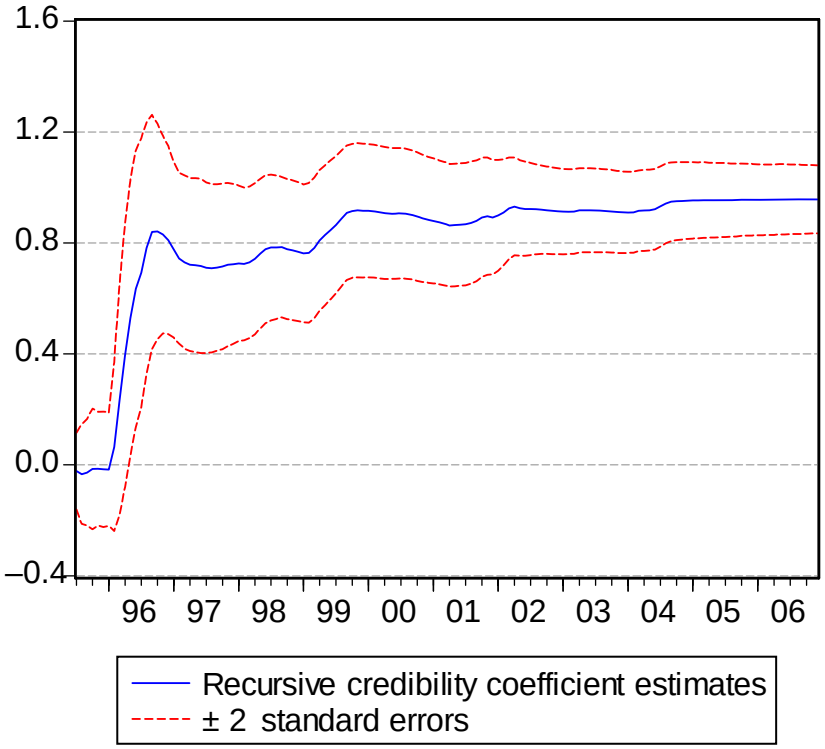
[14] Rossini (2001) tracks the range values together with their announcement dates and documentation.

where $\pi^{e}_{t,t+12}$ is the 12-month-ahead expectation of inflation taken at time t, π^{target}_{t+12} is the inflation target committed to be achieved 12 months ahead, π_{t-1} is the inflation observed one period before expectations are formed and α_t is the weight attached to the target when inflation expectations are formed. This coefficient can be interpreted as the credibility of the central bank on its commitment to achieve the target in the future.

The evolution of the credibility coefficient was estimated through recursive regressions. The results are depicted in Figure 3.

Figure 3

Credibility coefficients using recursive OLS regressions



During this period, the credibility parameter grows from values close to 0.8 at the end of the nineties to values that are closer to 1.0 in the inflation targeting period. This result points to the increasing anchoring of expectations by the central bank. This in turn favours the expectations channel. The importance of this finding is that, through this channel, changes in nominal interest rates induced by the central bank deliver nearly proportional changes in real interest rates (given that inflation expectations at medium to longer horizons are anchored by the target). Thus monetary policy becomes more powerful.

3.3 The credit channel

The evidence about the strength of this channel is weak for Peru. There have been two opposing forces behind this channel. First, higher capital mobility and domestic capital market developments have increased the available substitutes for bank credit such us financing through debt or equity in the capital markets. This has reduced the effectiveness of the credit channel. On the contrary, with increasing confidence in the banking system, higher bank intermediation has improved the effectiveness of this channel, as it replaces informal financing mechanisms.

The most recent empirical evidence on the importance of the credit channel relies on panel data at the firm level. Table 3 summarises the evidence; the bottom line is that the credit channel has not been relevant for monetary policy.[15] Even though the growth of private sector credit contributed to the expansionary phase observed in the period 1994–97, this occurred because large banks had sizeable credit lines with foreign banks. The posterior credit contraction (after the Asian crisis) is explained, first, by a decline of lending capacity (external lines were cut) and later, by banks' unwillingness to provide credit.[16]

Table 3

Empirical evidence

Credit channels

Studies	Methodology	Results
Bringas and Tuesta (1997)	VAR	– Liquidity effect prevails. Higher influence over monetary liabilities than credit levels.
Quispe (2001)	VAR	– Central bank has limited power to reduce the credit supply through financing reduction in domestic currency of banks.
Barajas and Steiner (2001)	Supply and demand model	– Evidence of credit rationing in Peru, caused by a lower disposition to provide it.
Berróspide and Dorich (2002)	Panel data	– Differentiated effects by bank type. Evidence of credit restriction only in larger banks.
Loo-Kung and Shiva (2003)	Panel data	– On average, monetary policy is not able to affect the overall supply of bank lending. – Evidence of lending channel in local currency in small banks. – Differentiated effects by bank size. Monetary policy has less power over larger banks.

3.4 Vulnerable balance sheets and their effect on monetary policy

One essential issue in a financially dollarised economy is the aggregate vulnerability of balance sheets resulting from sharp exchange rate depreciations[17] attributable, for example, to a sudden stop of capital inflows. This imposes a trade-off for policy makers between exchange rate flexibility and financial stability. In the short run policy makers should be cautious and cannot afford to neglect exchange rates movements. However, in the long run, they should recognize that in order to de-dollarise the economy, it is necessary to allow exchange rate flexibility.

[15] Moreover, within the past few years new alternative sources of finance have been developed, particularly bonds and commercial paper, thus reducing the direct credit channel effect.

[16] For the case of Peru, Barajas and Steiner (2001) find that the credit contraction observed during the crisis years was due mainly to the reduction of credit supply resulting from credit rationing. This occurred despite the fact that lending capacity recovered and demand for credit was strong.

[17] In extreme cases of financial fragility, sizeable unexpected exchange rate depreciations against the dollar increase the burden of dollar-denominated debts, weakening balance sheets and increasing the risks of financial distress.

The practice of monetary policy in emerging markets has indeed been shaped by the dilemma imposed by financial fragility. This is, for example, outlined in Amato and Gerlach (2002), which points out that on the path towards fully-fledged IT, many countries kept exchange rate targets and only slowly abandoned them. In fact, abandonment of exchange rate targets has usually not been undertaken until measures to mitigate financial vulnerability have been put in place.

The IT framework in Peru has included these elements of risk control within its special monetary policy design to foster financial stability.[18] However, like any risk mitigation approach, the Peruvian framework has been put in place without knowing the full extent of the balance-sheet effect, let alone its existence.

Empirical research has tackled the issue through two approaches: using micro panel data at the firm level and estimating aggregate macroeconomic data. The overall conclusions we can derive from the studies are twofold. First, the evidence on whether exchange rate depreciations are contractionary or expansionary is not conclusive. Second, exchange rate effects over the economy are likely to be non-linear and asymmetric (Table 4).

Table 4

Empirical evidence

Balance-sheet effects

Studies	Methodology	Results
Carranza et al (2003)	Panel	– Overall contractionary effects.
Jimenez (2005)	Panel	– Firms' indebtedness with banks is sensitive to exchange rate shocks. Smaller banks are more vulnerable.
Azabache (2006)	Panel	– Non-linear effects on loan portfolio of banks.
Castillo and Dorich (2005)	Panel	– Weak balance-sheet effect at the firm level, but important at the macro level.
Bigio and Salas (2006)	VAR	– Evidence of asymmetric contractionary real depreciation on output.
Leiderman (2006)	VAR	– Evidence of Granger causality from real bilateral exchange rate to nonperforming loans.

4. Dealing with uncertainty about exchange rate effects

The Central Bank of Peru adopted inflation targeting as a monetary policy framework in early 2002, thus becoming the only highly financially dollarised economy to become an ITer. As such, the design and implementation of IT therefore needs to pay special attention to the possible balance sheet consequences of currency mismatches and the potential run on dollar deposits in the banking system. The risks associated with sudden and sharp currency

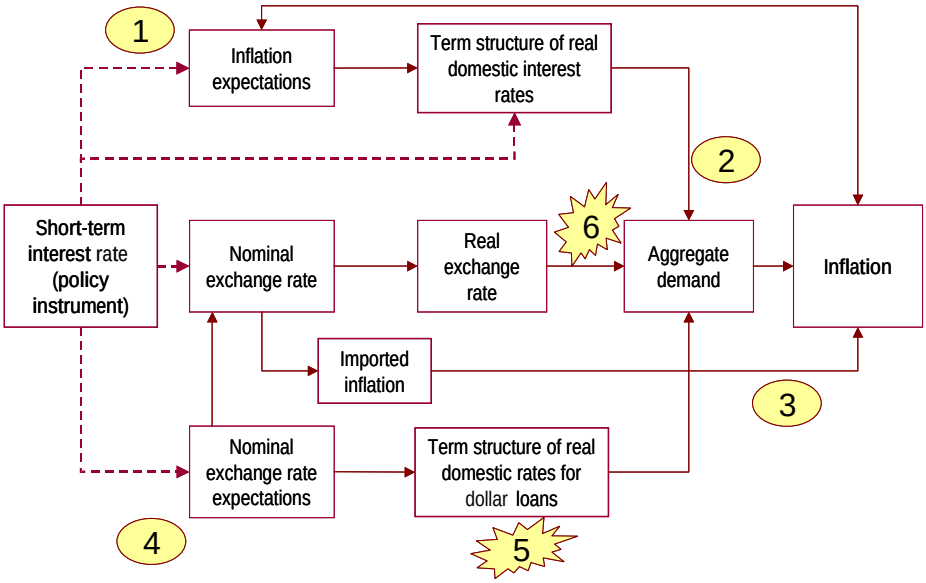
[18] In Armas and Grippa (2005), the risk control framework includes a series of measures besides the managed-floating approach to inflation targeting.

depreciations are not negligible. Therefore, the central bank takes a prudential approach to control these risks.[19]

The core quarterly forecasting model (QFM) relies on a simple structure that tries to capture the main findings about the transmission mechanism laid in the empirical survey of the previous section. Namely, it models the interest rate as well as the exchange rate and expectation channels.

Figure 4

The monetary policy transmission mechanism implied in the QFM structure



The mechanism depicted in Figure 4 resembles the standard monetary policy transmission theory in small open economies. In particular, we have stressed channels (1), (2), (3) and (4): the inflation expectations channel, the interest rate channel through aggregate demand, the pass-through from exchange rates to inflation, and exchange rate expectations channel, respectively. These channels behave in the same fashion as any other small open economy model, though financial dollarisation might have a bearing on the specific empirical sensitivities of endogenous variables within each of these channels.

Importantly, a financially dollarised economy imposes extra channels through which monetary policy can affect aggregate demand and inflation. Of course, financial vulnerabilities coming from sudden stops and exchange rate market distortions also spread through these channels with the potential to affect macroeconomic outcomes. These "vulnerability mechanisms" are labelled as (5) and (6) in the picture. Channel (5) represents the way long-run exchange rate expectations affect the real interest rate on dollar loanable funds to domestic borrowers. Furthermore, the cost of dollar loans for domestic borrowers is determined by the long-term foreign real interest rate plus the real depreciation rate. Lastly, channel (6) is the net real exchange rate impact on activity originated from balance-sheet as well as net export effects.

[19] See Armas and Grippa (2005) for a detailed account of the risk control approach under IT.

Empirical sensitivities at the aggregate level within these three channels are harder to identify. The empirical approaches at the firm level surveyed in this paper provide some rationale for the importance of exchange rate concerns in endogenous monetary policy reactions. However, the overall prudential approach taken by the central bank might have dampened latent and potential adverse effects in the recent past. Therefore, reduced form econometric exercises remain uncertain. So, what is urgent in the central bank research agenda is the structural estimation of deep parameters and the study of robust analysis to overcome the uncertainties regarding exchange rate effects.

In what follows we perform simple exercises taking into account the potential uncertainties that are embedded in the QFM. To do this, Table 5 presents the main equation blocks of the model[20] describing the mechanism depicted in Figure 4.

Table 5

Equations in the Quarterly Forecasting Model (QFM) for the Peruvian economy

Aggregate demand

$$y_t^{gap} = a_y y_{t-1}^{gap} - a_r r_{4,t-1}^{gap} - a_{rS} r_{4,t-1}^{S,gap} - a_{qb}\Delta q_{t-1}^{US,gap} + a_q q_{t-1}^{M,gap} + \xi_{y,t} \quad (1.1)$$

$$i_{4,t} = \tfrac{1}{4} E_t(i_t + i_{t+1} + i_{t+2} + i_{t+3}) + \varepsilon_{i4,t} \quad (1.2)$$

$$r_{4,t} = i_{4,t} - E_t[\pi_{4,t+4}^{core}] \quad (1.3)$$

$$i_{4,t}^{*} = \tfrac{1}{4} E_t(i_t^{*} + i_{t+1}^{*} + i_{t+2}^{*} + i_{t+3}^{*}) + \varepsilon_{i4^{*},t} \quad (1.4)$$

$$r_{4,t}^{S} = i_{4,t}^{*} + (E_t[e_{t+4}] - e_t) - E_t[p_{4,t+4}^{core}] \quad (1.5)$$

Inflation (supply)

$$\pi_t = g\pi_t^{non\_core} + (1-g)\pi_t^{core} \quad (2.1)$$

$$\pi_t^{core} = b_m \pi_{t-1}^{m} + (1-b_m)\{b_\pi \pi_{t-1}^{core} + (1-b_\pi)\pi_{t+1}^{e}\} + b_y y_{t-1}^{gap} + \varepsilon_{\pi,t} \quad (2.2)$$

$$p_t^{m} = r p_{t-1}^{m} + (1-r)[a_m p_{t-1}^{noncore\_fuel} + (1-a_m)(e_t - e_{t-1} + p_t^{*})] + e_{m,t} \quad (2.3)$$

Short-run exchange rate

$$\left(e_{t+1}^{e} - e_t\right) = i_t - i_t^{*} - prem_t - \varepsilon_{e,t} \quad (3.1)$$

$$e_{t+1}^{e} = c_s e_{t-1} + (1-c_s)E_t[e_{t+1}] \quad (3.2)$$

Monetary policy

$$i_t = f_i i_{t-1} + (1-f_i)\{i_t^{neutral} + f_\pi(E_t[\pi_{4,t+h}^{core}] - \pi_{ss}) + f_y[c_y y_t^{gap} + (1-c_y) y_{t-1}^{gap}]\} + \varepsilon_{i,t} \quad (4.1)$$

At first sight, the model is a standard small open economy model in the New Keynesian tradition. The first block contains the output gap as a function of one-year real interest rates and real exchange rates plus exogenous factors embedded in $\zeta_{y,t}$.

[20] A thorough exposition of the model can be found in Central Bank of Peru (2005).

Note that besides the domestic one-year real interest rate, the corresponding real dollar interest rate also plays a role in this equation. As long as the economy remains dollarised, a fraction of non-tradable producing agents will take dollar loans. Due to market segmentation, agents (without market power) cannot arbitrage when differences in expected costs among currencies arise. The relevant real rate of these loans is determined by equation (1.5), which measures the cost for agents with incomes in soles but liabilities in dollars. Here long-run exchange rate expectations have a direct impact on these real rates.

We can also note the presence of the bilateral exchange rate depreciation (through the term a_{qb}) together with the effective real exchange rate (through the term a_q). If a_{qb} were higher than a_q then, at the aggregate level, the balance-sheet effect channel would overshadow the net-export channel, as Carranza et al (2004) suggest.

The inflation block is also close to standard modelling practice. It considers the imported inflation effect (π_m) and the lagged output gap (y^{gap}) as well as inertial, expectations and exogenous supply factors. However, one issue that can arise is the strength of the pass-through in a dollarised economy. Given the estimations presented in Miller (2003), Winkelried (2003) and Leiderman (2006), the pass-through (the combined effects of parameters b_m and α_m) in the model is rather small.

The short-run exchange rate block is worthy of attention. It is normally expected that a rise in interest rates would have an appreciatory impact on the nominal spot exchange rate. This behaviour can be modelled by an uncovered interest parity relationship. However, most standard models assume the next-period exchange rate expectations are rational, which means the spot rate is indeed determined by the entire profile of interest rate differentials expected in the future. This fact makes the spot exchange rate a jumpy variable, which is compatible with a pure-floating exchange rate regime. However, exchange rate interventions by the central bank limit the volatility of the spot rate as viewed at the relevant quarterly frequencies. One way to introduce the impact of interventions is to introduce adaptive or inertial exchange rate expectations, as we do in equation (3.2). The more acute the intervention behaviour is, the less volatile the exchange rate becomes, so the inertial parameter c_s functions as a proxy of the degree of exchange rate interventions.[21]

Last, the monetary policy rule block is standard as well. The behaviour of the central bank is determined by an inflation-forecast targeting rule common in most central bank models.

Given this model structure, we perform two exercises dealing with uncertainty about the exchange rate effects. In our first exercise, we condition the model to extreme values of the c_s parameter; thus we in fact model how the behaviour of the transmission mechanism would change due to shift from lower to higher exchange rate intervention activities. In the second exercise we control for possible balance-sheet effects by trying different values for the real exchange parameters in the demand equation.

4.1 The role of foreign exchange market interventions

The central bank intervenes in the foreign exchange market to smooth undue fluctuations. Without intervention, any bubble-like behaviour would not be sustainable anyhow, and the market would correct deviations from equilibrium. However, the transition to equilibrium could nevertheless endanger financial markets in a dollarised economy. Along these lines, Morón and Winkelried (2005) suggest that it is optimal to dampen exchange rate fluctuations in a dollarised economy like Peru.

[21] The higher c_s is, the more inertial (and less volatile) the exchange rate is. Bofinger and Wollmershäuser (2003) explore another approach to model intervention. In their model, interventions affect the exchange rate premium so as to lean against the wind whenever good or bad news threatens to move the premium.

However, intervention policy faces a trade-off. On the one hand, excessive intervention could sustain dollarisation in the long run, as people do not internalise the risks of dollarisation, providing safe returns to dollar deposits and low costs to dollar debts. But on the other hand, episodes of excessive volatility (associated, for example, with a large and abrupt depreciation) would have a negative effect in the short run, affecting economic activity due to balance sheet vulnerabilities.

Thus, one direct and observable outcome of central bank intervention is the low variability of exchange rates. We use the QFM to simulate alternative degrees of intervention by moving the parameter c_s from 0 (no intervention) to a value equal to 1 (very strong intervention that makes exchange rates very smooth).

Figure 5

Responses to a 100 basis point rise in the interest rate when the exchange rate expectations parameters change

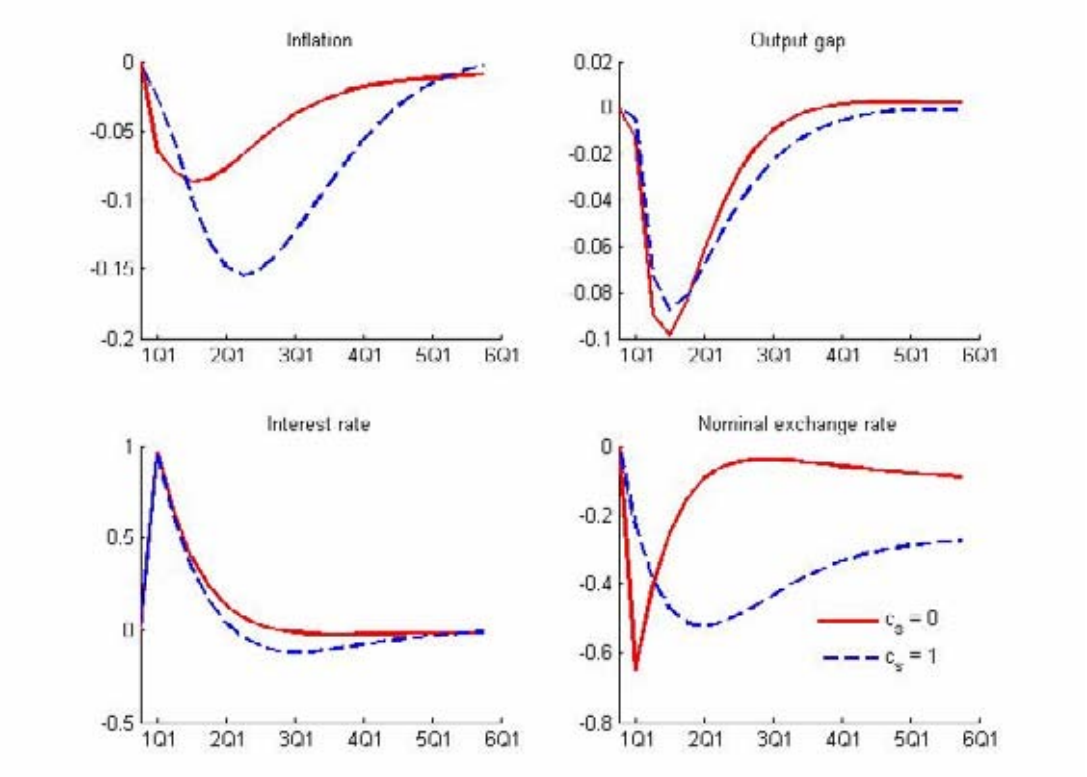


Figure 5 shows the response of the four main variables in the model. The solid line represents the high-exchange-rate volatility model whereas the discontinuous line stands for the low-exchange-rate volatility model. A monetary policy shock that implies a higher interest rate makes the domestic currency denominated bonds more attractive, causing a nominal exchange rate appreciation. The model implies that if the exchange rate were allowed to float more (by means of less intervention), the inflationary effect of exchange rate appreciation would be quicker but smaller. In contrast, more intervention implies a long lasting and stronger pass-through effect on inflation. Leiderman et al (2006) propose the hypothesis regarding a higher pass-through in dollarised economies. To fine-tune the hypothesis, given

the simulation result, it may well be the case that higher pass-through results from central bank intervention activities rather than dollarisation per se.[22]

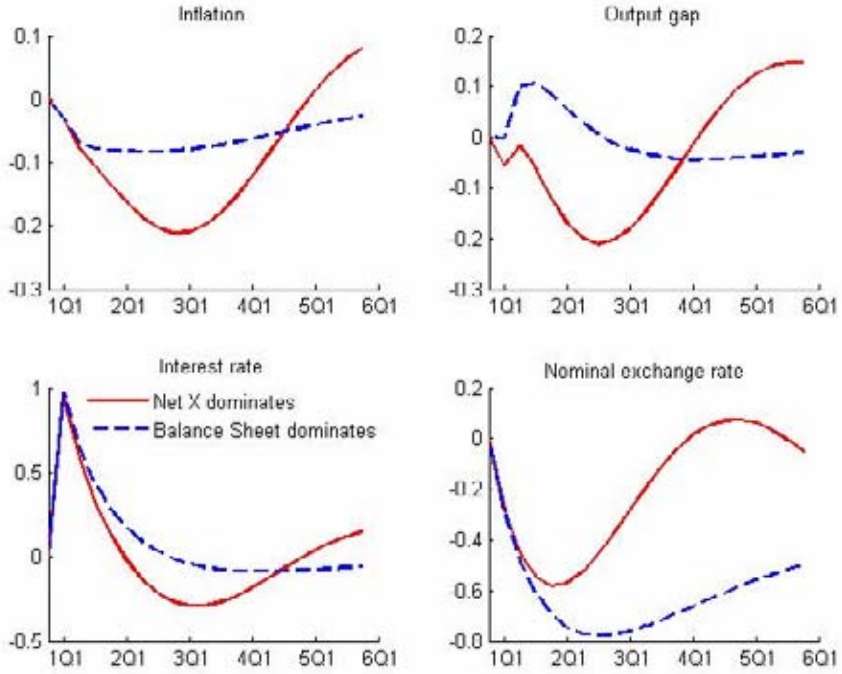
Regarding economic activity, the interest rate rise seems to have a stronger effect under the high-exchange-rate volatility model. This effect is the direct result of the net-exports effect embedded in the model. In reality, it may well be the case that the positive net-exports effect dominates only for small exchange rate movements, whereas the balance-sheet effect dominates whenever larger exchange rate shocks hit the economy. This potential non-linear effect is not modelled here.

4.2 The balance-sheet effect

How does the presence of the balance-sheet effect impinge on monetary policy's power to affect inflation? In Figure 6 we depict responses to an interest rate move to reduce the inflation rate. The exercises show again two possible cases. In the first case, the net-export effect dominates (the parameter a_q in equation (1.1) is set to 0.20, while the parameter a_{bq} is 0.14). The results are depicted in the solid line. In the second case, the parameter a_q is lowered to 0.05, which means that the balance-sheet effect dominates.

Figure 6

Responses to a 100 basis point rise in the interest rate under possible parameterisation of balance-sheet and net export effect on aggregate demand



[22] Successful interventions to smooth out volatility precisely deliver better information about where the exchange rate is heading. This information may serve price setters to pass-through more of the exchange rate's slow movements over the cycle.

In a standard open economy model, we would observe an appreciation of the currency and a fall in the output gap due to the real exchange appreciation, both effects thus reinforcing each other in equilibrium. In the modelling framework presented here, the above effects not necessarily reinforce each other. They may even offset each other and thereby weaken the monetary policy transmission channel.

As expected, under the balance-sheet model (discontinuous line) monetary policy's power is reduced due to the expansionary effect produced by the exchange rate appreciation. We observe that the output gap remains above zero for about a year after the contractionary interest rate move. So, taking into account the nominal exchange rate appreciation and the expansionary result in output, inflation still falls, but only timidly and in a long-lasting way.

5. Conclusions

We have performed an empirical survey with the following main findings:

- There is mixed evidence about the monetary policy transmission lags in Peru. There is, however, a hint of longer lags due to the use of the interest rate as the operating target.
- The pass-through channel from exchange rates to inflation is rather small, about 10 per cent within a year. These results are in line with other findings for Peru and elsewhere.
- The evidence about the credit channel is less convincing, but recent rapid de-dollarisation should help to reinforce it in the future.
- There is uncertainty about the balance-sheet effect because the evidence is not conclusive. If the effect indeed exists, it is likely to be non-linear and asymmetric. Macroeconomic time series analysis of this effect is hindered by the lack of enough controls.
- Lower financial dollarisation will reinforce the interest rate channel of monetary policy.
- A simple econometric test with expectation surveys suggests that the expectations channel has strengthened during these last years.

Financial dollarisation has two overall effects on monetary policy. First, it calls for an appropriate design of IT to control the inherent risks surrounding a dollarised environment. Second, it makes monetary policy less effective whenever the balance-sheet effect is strong.

Importantly, the transmission mechanism is endogenous to the particular monetary policy design put in place; for example, the degree of foreign exchange rate intervention changes the timing and strength of the pass-through mechanism. Namely, a lower degree of intervention makes the pass-through quicker but lower.

On the other hand, when the balance-sheet effect dominates over the net-export effect in the aggregate demand determination, a contractionary monetary policy expands output in the first year, and only after that time, the net-export effect appears. Regarding inflation determination, the resulting higher demand tends to offset the downward pressure coming from the exchange rate appreciation, delivering a small inflationary effect.

The interest rate channel seems to be effective in Peru because dollarisation is not of the currency substitution type. Central Bank of Peru estimates have shown that an increase in interest rates tends to feed through the banking overnight interest rate to the longer-term market interest rates and finally have an impact on aggregate demand and inflation.

Additionally, a reduction in financial dollarisation would reinforce this channel as well as the credit transmission mechanism.

References

Amato J and S Gerlach (2002): "Inflation targeting in emerging market and transition economies: Lessons after a decade", *European Economic Review*, 46, 781–790.

Armas, A, F Grippa, Z Quispe and L Valdivia (2001): "De metas monetarias a metas de inflación en una economía con dolarización parcial: el caso peruano", *Estudios Económicos*, no 7, Central Bank of Peru.

Armas, A and F Grippa (2006): "Targeting inflation in a dollarised economy: the Peruvian experience", *Financial dollarisation: the policy agenda*, IMF.

Azabache, P (2006): "Efectos no lineales entre el riesgo cambiario crediticio y la depreciación", mimeo, Central Bank of Peru.

Barajas, A and R Steiner (2002): "Credit stagnation in Latin America", *IMF Working Paper*, 02/53.

Berróspide, J and J Dorich (2002): "Aspectos microeconómicos de la restricción crediticia en el Perú", *Estudios Económicos*, no 8, Central Bank of Peru.

Bigio, S and J Salas (2006): "Efectos no lineales de choques de política monetaria y de tipo de cambio real en economías parcialmente dolarizadas: un análisis empírico para el Perú", Central Bank of Peru, *Working Paper*, 2006–08.

Bofinger, P and T Wollmershäuser (2003): "Managed floating as a monetary policy strategy", *Economics of Planning*, 36, 81–109.

Borio, C and A Filardo (2006): "Globalization and inflation, new cross-country evidence on the global determinants of domestic inflation", mimeo, Bank of International Settlements.

Bringas, P and V Tuesta (1997): "El superávit de encaje y los mecanismos de transmisión de la política monetaria: una aproximación", *Estudios Económicos*, no 1, Central Bank of Peru.

Central Bank of Peru (2005): "The quarterly forecast model", Annual Meeting of Economists of Central Bank of Peru.

Carranza, L, J Cayo and J Galdón (2003): "Exchange rate volatility and economic performance in Peru: a firm level analysis", *Emerging Markets Review*, 4 (2003), 472–496.

Castillo P and J Dorich (2005): "¿Existe el efecto hoja de balance en Peru?: evidencia de datos por firmas", mimeo, Central Bank of Peru.

De la Rocha, J (1998): "The transmission mechanism of monetary policy in Peru", in: *The transmission of monetary policy in emerging market economies*, *Bank for International Settlements Policy Papers*, no 3.

Deutsche Bank (2006): "LATAM Exchange rate pass-through", *Global Markets Research*, July.

Edwards, S (2006): "The relationship between exchange rates and inflation targeting revisited", *NBER Working Paper*, no 12163.

Frankel, J, D Parsley and W Shang-Jin: "Slow pass-through around the world: a new import for developing countries?", *NBER Working Paper*, no 11199.

Grippa, F (2004): "Measuring monetary policy in Peru", mimeo, London School of Economics.

Jimenez, R (2005): “Ciclo financiero y acelerador cambiario en una economía con alta dolarización financiera”, mimeo, Corporación Financiera de Desarrollo.

Lahura, E (2005): “El efecto traspaso de la tasa de interés y la política monetaria en el Perú: 1995–2004”, Central Bank of Peru, *Working Paper*, 2005–08.

Leiderman, L, R Maino, E and Parrado (2006): “Inflation targeting in dollarised economies”, *IMF Working Paper*, no 06/157.

Loo-Kung, R and M Shiva (2003): “El efecto de la política monetaria en la dinámica de los préstamos bancarios: un enfoque a nivel de bancos”, Young Economists Prize 2002–2003, Central Bank of Peru.

Miller, S (2003): “Estimación del pass-through del tipo de cambio a precios: 1995–2002”, *Estudios Económicos*, no 10, Central Bank of Peru.

Morón, E and D Winkelried (2005): “Monetary policy rules for financially vulnerable economies”, *Journal of Development Economics*, 76, 23–51.

Quispe, Z (2000): “Política monetaria en una economía con dolarización parcial: El caso del Perú”, *Estudios Económicos*, no 6, Central Bank of Peru.

——— (2001): Transmission mechanisms of monetary policy in an economy with partial dollarisation: the case of Peru”, *BIS Papers*, no 8, 210–231, Bank of International Settlements.

Rossini, R (2001): “Aspectos de la adopción de un régimen de metas de inflación en el Perú”, *Estudios Económicos*, no 7, Central Bank of Peru.

Vega M and D Winkelried (2005): “How does global inflation drag inflation in a small open economy?”, Central Bank of Peru, *Working Paper,* no 2005–1.

Winkelried, D (2003): “¿Es asimétrico el pass-through en el Perú?: Un análisis agregado”, *Estudios Económicos*, no 10, Central Bank of Peru.

——— (2004): “Tendencias comunes y análisis de la política monetaria en el Perú”, *Estudios Económicos*, no 11, Central Bank of Peru.